PUBLIC VOICE MAIL SERVICE FOR PRIVATE TELEPHONE EXCHANGE (PBX)

FIELD OF THE INVENTION

The present invention relates to voice mail facilities generally and more particularly to voice mail systems useful with private telephone switches.

BACKGROUND OF THE INVENTION

There exist in the patent literature many patents relating to voice mail systems. The following U.S. Patents represent the state of the art, as known to the inventor:

U.S. Patent 4,930,153, which is considered to be the most relevant relates to a PBX voice mail interface. The following U.S. patents, which are cited references in this patent are also believed to be relevant: 4,076,965; 4,254,304; 4,629,831; 4,636,584; 4,696,028; 4,792,967; 4,811,381. Reference is also made to "Patent Covers PBX-Integrated Call Routing" Voice News March, 1989.

Additional patents which are also thought to be relevant are U.S. Patents 4,823,378; 4,914,690 & 4,930,153, all invented by the inventor of U.S. Patent 4,930,153, mentioned above, 5,440,616; 5,450,488; 5,469,491; 5,187,735.

SUMMARY OF THE INVENTION

The present invention seeks to provide a voice mail facility, system, interface and method for use with private telephone switches and which is characterized by greatly enhanced cost-effectiveness as compared with the prior art.

There is thus provided in accordance with a preferred embodiment of the present invention a shared central office voice mail system for use with private telephone switches, the system including a central voice mail unit connected to a central office; and a plurality of interfaces each coupled to one of a plurality of private telephone switches which are each connected to a central office, each of the interfaces also being connected to the central voice mail unit.

There is also provided in accordance with a preferred embodiment of the present invention a telephone network having a shared central office voice mail capability including:

a plurality of private telephone switches connected to the central office by telephone lines a central voice mail unit connected to a central office; and

a plurality of interfaces each coupled to one of the plurality of private telephone switches which are each connected to a central office, each of the interfaces also being connected to the central voice mail unit.

There is additionally provided in accordance with a preferred embodiment of the present invention a shared central office voice mail method for use with private telephone switches, the method including connecting a central voice mail unit to a central office; and coupling a plurality of interfaces each to one of a plurality of private telephone switches which are each connected to a central office, each of the interfaces also being connected to the central voice mail unit.

In accordance with one embodiment of the present invention, each of the plurality of interfaces is connected to an extension connection of a private telephone switch.

Preferably, each of the plurality of interfaces is also connected via a control connection to the private telephone switch.

According to another embodiment of the present invention, at least one of the interfaces is directly connected to the central voice mail unit via at least one dedicated line.

According to yet another embodiment of the present invention, at least one of the interfaces is connected to the central voice mail unit via the central office and at least one dedicated line.

According to an embodiment of the present invention, at least one of the interfaces is directly connected to the central voice mail unit via the central office and at least one telephone line.

In accordance with a preferred embodiment of the present invention at least one of the interfaces is incorporated in a private telephone switch.

Additionally in accordance with a preferred embodiment of the present invention, the system also includes at least one computer system cooperating with at least one of the private telephone switches for providing unified messaging.

In accordance with one embodiment of the present invention the PBX and the public voice mail itnerface are connected to the same central office. Alternatively, the PBX and the public voice mail interface are connected to first and second separate central offices. The second central office may be a cellular central office.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

Fig. 1A is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance with one preferred embodiment of the present invention;

Fig. 1B is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 1A;

Fig. 2A is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance with another preferred embodiment of the present invention;

Fig. 2B is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 2A;

Fig. 3A is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance with yet another preferred embodiment of the present invention;

Fig. 3B is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 3A;

Fig. 4A is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance with still another preferred embodiment of the present invention;

Fig. 4B is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 4A;

Fig. 5 is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiments of Figs. 1A, 2A, 3A and 4A;

Fig. 6 is a block diagram illustration of a public voice mail interface useful in the embodiments of Figs. 1A and 1B;

Fig. 7 is a block diagram illustration of a public voice mail interface useful in the embodiments of Figs. 2A and 2B;

Fig. 8 is a block diagram illustration of a public voice mail interface useful in the embodiments of Figs. 3A and 3B;

Figs. 9A & 9B together are a flow chart illustrating preferred operation of the present invention;

Figs. 10, 11 and 12 are each a flow chart illustrating operation of a service provided by the present invention;

Fig. 13 is a flow chart illustrating the principal subroutine employed by the public voice mail interfaces of Figs. 6 & 7;

Fig. 14 is a more detailed flow chart illustrating a first portion of the subroutine of Fig. 13:

Fig. 15A is a more detailed flow chart illustrating a first portion of the subroutine of Fig. 14, and also a first portion of Fig. 16;

Fig. 15B is a more detailed flow chart illustrating a second portion of the subroutine of Fig. 14, and also a second portion of Fig. 16;

Fig. 16 is a more detailed flow chart illustrating a second portion of the subroutine of Fig. 13;

Fig. 17 is a more detailed flow chart illustrating a third portion of the subroutine of Fig. 13;

Fig. 18 is a more detailed flow chart illustrating a fourth portion of the subroutine of Fig. 13;

Fig. 19 is a flow chart illustrating the principal subroutine employed by the public voice mail interfaces of Fig. 8;

Fig. 20 is a more detailed flow chart illustrating a first portion of the subroutine of Fig. 19;

Fig. 21 is a more detailed flow chart illustrating a second portion of the subroutine of Fig. 19;

Figs. 22A and 22B are simplified block diagram illustrations of two alternative embodiments of a public voice mail system coupled to a central office, a LAN and a PBX for providing unified messaging in accordance with one preferred embodiment of the present invention;

Fig. 23 is a block diagram illustration of a public voice mail interface useful in the embodiment of Fig. 22A;

Fig. 24 is a block diagram illustration of a public voice mail interface useful in the embodiment of Fig. 22B;

Fig. 25A is a simplified block diagram illustration of a cellular public voice mail system coupled to a cellular central office and a PBX in accordance with another preferred embodiment of the present invention representing a modification of the embodiment of Fig. 2A; and

Fig. 25B is a simplified block diagram illustration of a plurality of cellular public voice mail systems coupled to cellular central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 25A.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1A, which is a simplified block diagram illustration of a public voice mail system (PVMS) coupled to a central office (CO) and a private branch exchange (PBX) in accordance with one preferred embodiment of the present invention. In the embodiment of Fig. 1A, a PBX 100, such as HKP-410/820 from Hyundai Electronics Industries Co. Ltd., is connected to a public voice mail system 102. A plurality of PBX telephone extensions 104 are connected, via a public voice mail interface (PVMI) 106, to an equal number of lines 108 of the voice mail system 102. The number of extensions 104 is equal to the sum of the number of PBX subscriber telephones 110 which are to be provided concurrently with voice mail service plus the number of outside callers to the PBX who are to be provided concurrently with voice mail service. A control link 112 may optionally be provided between the PBX 100 and the public voice mail interface 106.

It is appreciated that in this embodiment, and throughout this present patent application and claims, that the terms "serial data link" and "control line" are identical and may be interchanged.

The public voice mail system 102 is connected, in turn, to a central office 114 by means of suitable telephone lines 116. Optionally, the voice mail system 102 and the central office 114 may also be connected by means of an additional data link 118, which carries data and control signals between the central office 114 and the voice mail system 102.

The PBX 100 is connected to the central office 114 by means of conventional telephone lines 120. The PBX 100 may communicate with the public voice mail system 102 either via the central office 114, through telephone lines 120 and 116 and optionally via data link 118. Preferably, however, the PBX 100 communicates with the public voice mail system 102 via telephone extensions 104 and via telephone lines 108.

The control signals communicated between the PBX 100 and the public voice mail interface 106 over line 112 may be communicated between public voice mail interface 106 and voice mail system 102 as DTMF signals or as modem signals. Consequently, this communication may be over a line 108 which is not currently in use, over a dedicated one of lines 108 connected to a modem selected from a modem pool 122 at the public voice mail side of the line 108, or over a line 108 which is in use, in a "Data over Voice" mode of operation. Alternatively, in this and the other embodiments described herein, the modem pool 122 may be eliminated in a case where the public voice mail system is operative, inter alia, to emulate

modems over lines 108. Modem pool may be connected to the public voice mail interface via a serial link 123, which may be embodied as one of lines 108.

The public voice mail system 102 preferably contains mailboxes allocated to telephone extensions and individuals associated with the PBX. It is possible to access these mailboxes by means of subscriber telephones 110 connected to the PBX or by means of any other telephone connected to the telephone network.

Reference is now made to Fig. 1B, which is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 1A. Elements in Fig. 1B which may be identical to those appearing in Fig. 1A are indicated by identical reference numerals.

It is appreciated that the number of telephone lines 108 which interconnect a public voice mail system 102 to an interface 106 may vary, as indicated. It is seen that a shared public voice mail system 124 may be connected to more than one central offices 126 and 128. It is also seen that multiple public voice mail interfaces 106 may be interconnected between a PBX 100 and a public voice mail system 102 such as between PBX 130 and a public voice mail system 124. It is additionally seen that in a configuration illustrated generally by reference numeral 132 a PBX 134 receives voice mail service via an interface 136 which is connected to public voice mail system 124 which is not directly connected to the central office 138 which services PBX 134.

Reference is now made to Fig. 2A which is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance with another preferred embodiment of the present invention. In the embodiment of Fig. 2A, a PBX 200, is connected to a public voice mail system 202. A plurality of PBX telephone extensions 204 are connected, via a public voice mail interface 206, to an equal number of lines 208 of the central office 210 and through lines 212 to the voice mail system 202.

The number of extensions 204 is equal to the sum of the number of PBX subscriber telephones 242 which are to be provided concurrently with voice mail service plus the number of outside callers to the PBX 200 who are to be provided concurrently with voice mail service. A control link 214 may optionally be provided between the PBX 200 and the public voice mail interface 206.

Optionally, the voice mail system 202 and the central office 210 may also be connected by means of an additional data link 216, which carries data and control signals between the central office 210 and the voice mail system 202.

The PBX 200 is connected to the central office 210 by means of conventional telephone lines 218. The PBX 200 may communicate with the public voice mail system 202 either via the central office 210, through telephone lines 218 and 212 and optionally via data link 216. Preferably, however, the PBX 200 communicates with the public voice mail system 202 via telephone extensions 204, public voice mail interface 206, the telephone lines 208, the central office 210, and telephone lines 212.

The signals communicated between the PBX 200 and the public voice mail interface 206 over line 214 may be communicated between public voice mail interface 206 and voice mail system 202 as DTMF signals or as modem signals. Consequently, this communication may be over a line 208 which is not currently in use, over a dedicated one of lines 208 connected, through the central office 210 and a line 220 to a one modem of a modem pool 222, or over a line 208 which is in use, in a "Data over Voice" mode of operation. Modem pool 222 communicates via the central office 210 with the public voice mail interface 206 via a serial link 223, which may be embodied as one of lines 208.

The public voice mail system preferably contains mailboxes allocated to telephone extensions and individuals associated with the PBX. It is possible to access these mailboxes by means of subscriber telephones 242 connected to the PBX or by means of any other telephone connected to the telephone network.

Reference is now made to Fig. 2B, which is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 2A. Elements in Fig. 2B which may be identical to those appearing in Fig. 2A are indicated by identical reference numerals.

It is appreciated that the number of telephone lines 208 which interconnected a public voice mail system 202 to an interface 206 may vary, as indicated. It is seen that a shared public voice mail system 224 may be connected to more than one central office 210, such as central offices 226 and 228. It is also seen that multiple public voice mail interfaces 206 may be interconnected between a PBX 200 and a central office 210 such as between PBX 230 and central office 228. It is additionally seen that in a configuration illustrated generally by reference numeral 232 a PBX 234 receives voice mail service via an interface 236 which is connected to a central office 238 which is not directly connected to the voice mail system 224 which services PBX 234.

Reference is now made to Fig. 3A which is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance

with yet another preferred embodiment of the present invention. In the embodiment of Fig. 3A, a PBX 300 is connected to a central office 302, via a plurality of PBX telephone lines 304 and a public voice mail interface 306, to an equal number of lines 308 of the central office 302. Additionally PBX 300 is connected via a plurality of PBX extensions 310, typically less or equal to the number of central office lines 308, via the public voice mail interface 306 and lines 308, the central office 302 and through the lines 312 to the voice mail system 314.

The number of extensions 304 is equal to the sum of the number of PBX subscriber telephones 316 which are to be provided concurrently with voice mail service plus the number of outside callers to the PBX 300 who are to be provided concurrently with voice mail service. A control link 318 may optionally be provided between the PBX 300 and the public voice mail interface 306.

Optionally, the voice mail system 314 and the central office 302 may also be connected by means of an additional data link 320, which carries data and control signals between the central office 302 and the voice mail system 314.

The PBX 300 may communicate with the public voice mail system 314 via telephone lines 304, 308 and 312. Preferably, however, the PBX 300 communicates with the public voice mail system 314 via telephone extensions 310, public voice mail interface 306, central office 302, and telephone lines 312.

The signals communicated between the PBX 300 and the public voice mail interface 306 over line 304 may be communicated between public voice mail interface 306 and voice mail system 314 as DTMF signals or as modem signals. Consequently, this communication may be over a line 308 which is not currently in use, over an additional dedicated line 344, through the central office 302 and a line 324 to a one modem of a modem pool 326, or over a line 308 which is in use, in a "Data over Voice" mode of operation.

The public voice mail system contains mailboxes allocated to telephone extensions and individuals associated with the PBX. It is possible to access these mailboxes by means of subscriber telephones 316 connected to the PBX or by means of any other telephone connected to the telephone network.

Reference is now made to Fig. 3B, which is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 3A. Elements in Fig. 3B which may be identical to those appearing in Fig. 3A are indicated by identical reference numerals.

It is appreciated that the number of telephone lines 308 which interconnect the PBX and the central office may vary and that the number of extensions 310 that also interconnect the PBX and the public voice mail interface 306 may vary, as indicated. It is seen that a shared public voice mail system 328 may be connected to more than one central office 302, such as central offices 330 and 332.

It is also seen that multiple public voice mail interfaces 306 may be interconnected between a PBX 300 and a central office 302 such as between PBX 334 and central office 332. It is additionally seen that in a configuration illustrated generally by reference numeral 336 a PBX 338 receives voice mail service via an interface 340 which is connected to central office 342 which is not directly connected to the voice mail system 328 which services PBX 338.

Reference is now made to Fig. 4A, which is a simplified block diagram illustration of a public voice mail system coupled to a central office and a PBX in accordance with still another preferred embodiment of the present invention. In the embodiment of Fig. 4A, a PBX 400 is connected to a voice mail system 402, via a plurality of telephone lines 404 of the central office 406 and through lines 408 to the voice mail system 402.

The features of the public voice mail interface (106, 206 and 306 of Figs 1A, 2A and 3A respectively) are implemented as a part of the software of the PBX. A digital control link may optionally be provided between the PBX 400 and the public voice mail system 402 over one of lines 404 and through a line 410 to a modem 412.

Data and control signals communicated between the PBX 400 and the public voice mail system 402 over line 404 may be communicated as DTMF signals over lines 408 or as modem signals over lines 410. Consequently, this communication may be over a line 404 which is not currently in use, over an additional dedicated line 404, through the central office 406 and a line 410 to a one modem of a modem pool 412, or over a line 404 which is in use, in a "Data over Voice" mode of operation.

Optionally, the voice mail system 402 and the central office 406 may also be connected by means of an additional data link 414, which carries data and control signals between the central office 406 and the voice mail system 402.

The public voice mail system contains mailboxes allocated to telephone extensions and individuals associated with the PBX. It is possible to access these mailboxes by means of subscriber telephones 416 connected to the PBX or by means of any other telephone connected to the telephone network.

Reference is now made to Fig. 4B, which is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiment of Fig. 4A. Elements in Fig. 4B which may be identical to those appearing in Fig. 4A are indicated by identical reference numerals.

It is appreciated that the number of telephone lines 404 which interconnect the PBX and the central office and thus also the public voice mail system may vary, as indicated. It is seen that a shared public voice mail system 418 may be connected to more than one central office 402, such as central offices 420 and 422. It is additionally seen that in a configuration illustrated generally by reference numeral 424, a PBX 426 is connected to central office 428 which is not directly connected to the voice mail system 418 which services PBX 426.

Reference is now made to Fig. 5 which is a simplified block diagram illustration of a plurality of public voice mail systems coupled to central offices and PBXs in a telephone network in accordance with the embodiments of Figs. 1A, 2A, 3A and 4A.

PBX 500 employs the configuration shown in Fig. 1A. PBX 500 is connected with central office 502 and also communicates, through public voice mail interface 504, with public voice mail system 506. PBX 508 uses a direct control line 516 to communicate with public voice mail system through a modem in modem pool 518. PBX 500 uses one of its lines 520 that is available at the time to communicate control signals with public voice mail system 506. PBX 508 also employs the configuration shown in Fig. 1A. PBX 508 is connected with central office 510 and also communicates, through public voice mail interface 512 with public voice mail system 514.

PBX 522 employs the configuration shown in Fig. 2A. PBX 522 is connected with central office 524 and also communicates, through public voice mail interface 526, also through central office 524, with public voice mail system 506. PBX 528 also employs the configuration shown in Fig. 2A. However PBX 528 uses two public voice mail interfaces 530 and 532 to communicate, through central office 510 with public voice mail system 514.

PBX 534 employs the configuration shown in Fig. 3A. PBX is connected, through public voice mail interface 536 with central office 538. PBX 534 communicates with public voice mail system 506 via public voice mail interface 536, via central office 538 and via central office 502. PBX 540 also employs the configuration of Fig 3A. However, PBX 540 uses two public voice mail interfaces 542 and 544 to communicate with public voice mail system 506 through central office 524.

PBX 546 employs the configuration shown in Fig. 4A. PBX 546 is connected to central office 502 through which it communicates with public voice mail system 506.

Reference is now made to Fig. 6, which is a block diagram illustration of a public voice mail interface useful in the embodiments of Figs. 1A and 1B. The interface of Fig. 6 is illustrated for an embodiment which embodies two twisted pair copper connections 614 between the PBX 100 (Fig. 1A) and the public voice mail system 102 (Fig. 1A). Connectors 610 and 612 each connect a twisted pair 614 to a corresponding PBX extension 104 (Fig. 1A), while connectors 616 and 618, each connect the twisted pair 614 to a corresponding telephone line 108 (Fig. 1A).

A single line module 622 interconnects connectors 610 and 616, while a single line module 624, which may be identical to module 622, interconnects connectors 612 and 618. Line module 622 includes a normally open DPDT relay 626 which is operated by a line driver 628 and which, when open, separates the twisted pair 614 into a PBX side portion 629 and a public voice mail system side portion 630.

Line driver 628 also controls a pair of line interfaces 631 and 632. Upon suitable indication from the line driver 628 the line interface 631 sends an ON-HOOK or an OFF-HOOK signal to line portions 629. Line interfaces 631 and 632 also sense the line impedance which indicates OFF-HOOK or ON-HOOK status of their respective line portions 629 and 630 and provide suitable indications thereof to the line driver 628.

Line driver 628 also receives an input from a ring detector 634 which receives an input from the PBX side 629 via line interface 631. Upon detection of a ring, the ring detector 634 signals the line driver 628, which provides a corresponding output to a micro-controller 636, via a bus 638. Upon suitable indication from a line driver 628 the ring generator 640 sends a ringing signal to line portion 630 via line interface 632.

The line interfaces 631 and 632 also receive DTMF inputs from respective DTMF transmitters 642 and 644, which, in turn, receive inputs from micro-controller 636 via bus 638. The line interfaces 631 and 632 are operative to couple the DTMF inputs to their respective line portions 629 and 630.

The line interfaces 631 and 632 also provide outputs to corresponding DTMF receivers 646 and 648. DTMF transmitters 642 and 644 and DTMF receivers 646 and 648 are connected via bus 638 with micro-controller 636.

Line module 624, which communicates with the other twisted pair 614 may be identical to line module 622, described hereinabove. It is appreciated that only a single line

module or more than two line modules may be provided in accordance with a preferred embodiment of the present invention.

Bus 638 interconnects micro-controller 636 and line modules 622 and 624 with ROM and RAM memories 660 and 662 as well as with a non-volatile memory 664. A USART circuit 668 communicates with bus 638 and is connected via a serial line driver 670 and a connector 672 with control link 112 (Fig. 1A) which in turn, communicates with PBX 100. A second USART circuit 674 communicates with bus 638 and is connected via a serial line driver 676, preferably also via a modem 678, via an impedance balance 680 and a connector 682 with a serial data link 123 (Fig. 1A).

When the serial data link to the voice mail system 102 (Fig. 1A) is not a dedicated link such as link 123 (Fig. 1A), modem 678 communicates not via connector 682 but rather via one of the wires constituting portion 630. Modem 678 is preferably selectably connected to an available twisted pair portion 630 of either of twisted pairs 614 by means of an appropriate relay 684.

Reference is now made to Fig. 7, which is a block diagram illustration of a public voice mail interface useful in the embodiments of Figs. 2A and 2B. The interface of Fig. 7 is illustrated for an embodiment which embodies two twisted pair copper connections between the PBX 200 (Fig. 2A) and the public voice mail system 202 (Fig. 2A) via a central office 210.

Connectors 710 and 712 each connect a twisted pair 714 to a corresponding PBX telephone extension 204 (Fig. 2A), while connectors 716 and 718, each connect a twisted pair 714 to a corresponding telephone line 208 (Fig. 2A). A single line module 722 interconnects connectors 710 and 716, while a single line module 724, which may be identical to module 722, interconnects connectors 712 and 718.

Line module 722 includes a normally open DPDT relay 726 which is operated by a line driver 728 and which, when open, separates the twisted pair 714 into a PBX side portion 729 and a central office side portion 730

Line driver 728 also controls a pair of line interfaces 731 and 732. Upon suitable indication from the line driver 728, the line interfaces 731 and 732 send an ON-HOOK or an OFF-HOOK signal to line portions 729 and 730 respectively. Line interfaces 731 and 732 also sense the line impedance which indicates OFF-HOOK or ON-HOOK status of their respective line portions 729 and 730 and provide suitable indications thereof to the line driver 728.

Line driver 728 also receives an input from ring detectors 734 and 736 which receive an input from line interfaces 730 and 732 respectively. Upon detection of a ring, the ring detectors 734 and 736 signal the line driver 728, which provides a corresponding output to a micro-controller 738, via a bus 640.

The line interfaces 731 and 732 also receive DTMF inputs from respective DTMF transmitters 742 and 744, which, in turn, receive inputs from micro-controller 738 via bus 740. The line interfaces 731 and 732 are operative to couple the DTMF inputs to their respective line portions 729 and 730.

The line interfaces 731 and 732 also provide outputs to corresponding DTMF receivers 746 and 748. DTMF transmitters 742 and 744 and DTMF receivers 746 and 648 are connected via bus 740 with micro-controller 738.

Line module 724, which communicates with the other twisted pair 714, may be identical to line module 722, described hereinabove, which communicates with twisted pair 714. It is appreciated that only a single line module or more than two line modules may be provided in accordance with a preferred embodiment of the present invention.

Bus 740 interconnects micro-controller 738 and line modules 722 and 724 with ROM and RAM memories 760 and 762 as well as a non-volatile memory 764. A USART circuit 768 communicates with bus 740 and is connected via a serial line driver 770 and a connector 772 with serial data link 214 (Fig. 2A) which in turn, communicates with PBX 200. A second USART circuit 774 communicates with bus 740 and is connected via a serial line driver 776, preferably also via a modem 778, via an impedance balance 780 and a connector 782 with serial data link 223 (Fig. 2A).

When the serial data link 223 to the voice mail system 202 (Fig. 2A) is not a dedicated link, modem 778 communicates not via connector 782 but rather via an available one of twisted pairs 714 or 720. Modem 778 is preferably selectably connected to a side portion 730 by means of an appropriate relay 784.

Reference is now made to Fig. 8, which is a block diagram illustration of a public voice mail interface useful in the embodiments of Figs. 3A and 3B. The interface of Fig. 8 is illustrated for an embodiment which embodies two twisted pair copper connections between the PBX 300 (Fig. 3A) and the public voice mail system 314 (Fig. 3A) via the central office 302.

Connectors 810 and 812 each connect, respectively, twisted pairs 814 to a corresponding PBX extensions 310 (Fig. 3A). Connectors 818 and 820 each connect,

respectively, the same twisted pairs 814 to a corresponding PBX lines 304 (Fig. 3A) while connectors 822 and 824, each connect, respectively, the other sides of twisted pairs 814 to a corresponding central office telephone lines 308 (Fig. 3A).

Line module 826 includes a normally open DPDT relay 828 which is operated by a line driver 830 and which switches the twisted pair 814 between the PBX line connector 818 and PBX extension connector 810.

Line driver 830 also controls the three line interfaces 832, 834 and 836. Upon suitable indication from the line driver 830, the line interfaces 832, 834 and 836 send an ON-HOOK or an OFF-HOOK signal to their respective line portions 838, 840 and 842. Line interfaces 838, 840 and 842 also sense the line impedance which indicates OFF-HOOK or ON-HOOK status of their respective line portions 838, 840 and 842 and provide suitable indications thereof to the line driver 830.

Line driver 830 also receives an input from the ring detectors 844 and 846 which receive an input from line interfaces 832 and 836 respectively. Upon detection of a ring, the ring detectors 844 and 846 signal the line driver 830, which provides a corresponding output to a micro-controller 848, via a bus 850.

The line interfaces 832 and 836 also receive DTMF inputs from respective DTMF transmitters 852 and 854, which, in turn, receive inputs from micro-controller 848 via bus 850. The line interfaces 832 and 836 are operative to couple the DTMF inputs to their respective lines portions 838 and 842.

The line interfaces 832 and 836 also provide outputs to corresponding DTMF receivers 856 and 858. DTMF transmitters 852 and 854 and DTMF receivers 856 and 858 are connected via bus 850 with micro-controller 848.

Line module 828, which communicates with the other twisted pair 814, may be identical to line module 826, described hereinabove, which communicates with twisted pair 814. It is appreciated that only a single line module or more than two line modules may be provided in accordance with a preferred embodiment of the present invention.

Bus 850 interconnects micro-controller 848 and line modules 826 and 828 with ROM and RAM memories 860 and 862 as well as a non-volatile memory 864. A USART circuit 868 communicates with bus 850 and is connected via a serial line driver 870 and a connector 872 with serial data link 318 (Fig. 3A) which in turn, communicates with PBX 300. A second USART circuit 874 communicates with bus 850 and is connected via a serial line

driver 876, preferably also via a modem 878, via an impedance balance 880 and a connector 882 with serial data link 344 (Fig. 2A).

When the serial data link to the voice mail system 314 (Fig. 3A) is not a dedicated link, modem 878 communicates not via connector 882 but rather via an available one of twisted pairs 814 or 816. Modem 878 is preferably selectably connected to a side portion 842 by means of an appropriate relay 884.

Reference is now made to Fig. 9A and Fig. 9B which together comprise a simplified flow chart illustrating a general process whereby a caller accesses and uses public voice mail services in accordance with a preferred embodiment of the present invention. The process relates to two principal services: auto-attendant, including the call routing feature thereof, and message handling, including three main features thereof: message recording, message retrieving and message waiting indication (MWI). Although there are many additional features associated with voice processing, these additional features are implemented and provided in a similar manner to these four basic features. The process may be the same for all the configurations described hereinabove with reference to Figs. 1A and 1B; Figs. 2A and 2B; Figs. 3A and 3B; Figs. 4A and 4B; and Fig. 5.

In step 900 a telephone call to the voice mail service is initiated. The call can be (step 902) either direct, from any telephone set 550 or 560 (Fig. 5) but not via a public voice mail interface, through the public telephone network to the appropriate public voice mail system, or indirect, through any of the PBXs 500, 508, 522, 528, 534, 540 and 546 (Fig. 5) via its respective public voice mail interface to its respective public voice mail system.

A direct call to the public voice mail system is performed (step 904) in a manner similar to a conventional call to the public voice mail system (step 906). The caller can leave a message, retrieve his messages or create and send messages. If a message waiting indication had earlier been activated, upon retrieval of the messages by the caller, the message waiting indication is deactivated (step 908).

An indirect call through the PBX can be initiated either (step 912) from an outside telephone 550 (Fig. 5) or a PBX subscriber telephone 560 (Fig. 5) of the same PBX. A call from a PBX subscriber telephone 560 (Fig. 5) that is dialed to a second PBX and through the public voice mail interface of the second PBX to the public voice mail service is considered an indirect call.

When a subscriber of the PBX places an inside call (step 914) either to the voice mail service (to retrieve his messages, to create and send messages, or to modify some

parameters of his voice mailbox), or to another extension. In the former option the PBX subscriber dials (step 916) to one of the PBX extensions that is connected to the public voice mail interface and then dials the code of the requested service (e.g. voice mail) and the identification number of the requested voice mailbox. The process proceeds in a manner similar to that of the direct call (steps 906 and 908).

In the latter option the subscriber calls another subscriber extension that does not answer and therefore the subscriber is routed by the PBX to one of the PBX extensions which is connected to the public voice mail interface. The remainder of this procedure is described below with reference to an outside caller.

When an outside caller, either from a telephone 550 (Fig. 5) or a telephone 560 (Fig. 5) connected to another PBX, dials into the PBX (step 918) the call can be routed to the public voice mail service either automatically or manually (step 920).

In automatic routing (step 922), shown in both Figs. 9A and 9B, the PBX forwards the call to one of its extensions that is connected to the public voice mail interface. The public voice mail interface connects the call to the public voice mail system and the public voice mail system provides the required service, normally, auto-attendant service (step 924 of Fig. 9B).

The auto-attendant service provides the caller with a voice menu that enables the caller to select an extension to be transferred to. If the selected extension does not answer the call (step 926), the caller can select (step 928) to leave a message in the voice mailbox associated with that extension (step 930). Typically, after the message is recorded a message waiting indication is activated (step 932) if it is available and the process ends (step 934).

In manual routing a subscriber of the PBX answers the call and then routes the caller to the desired extension (step 936 of Fig. 9A) or asks the caller to leave a message using the voice mail service (step 938) or to the auto-attendant service (step 940), shown in Figs. 9A & 9B, as he finds appropriate.

If the subscriber has routed the call to the auto-attendant service (step 940 of Fig. 9B) he transfers the call to one of the PBX extensions that are connected to the public voice mail interface. The public voice mail interface connects the call to the public voice mail system. The PBX subscriber can now (step 942) add the code of the required service (auto-attendant) and disconnect. The public voice mail system then provides the required service to the caller in the same manner that was described above for automated routing, i.e. steps 924, 926, 928, 930, 932 and 934 of Fig. 9B.

If the subscriber has routed the caller to leave a message in the voice mail service (step 944 of Fig. 9A) he or she transfers the call to one of the PBX extensions that are connected to the public voice mail interface. The public voice mail interface connects the call to the public voice mail system. The PBX subscriber can now (step 946) add the code of the voice mail service, add the identification code of the voice mailbox of the subscriber to whom the caller wishes to leave a message and then disconnects. The public voice mail system now provides the required service to the caller in the same manner that was described above for the recording of a message(steps 930, 932 and 934 of Fig. 9B).

If the subscriber has routed the caller to another telephone extension and the call to that extension is not answered (step 948 of Fig. 9A) there are two possibilities (step 950): either the PBX transfers the call to the voice mail service automatically (step 952) or the call returns to the subscriber who transferred it (step 944). In the latter case, the subscriber typically continues as described above for manual transfer to a voice mail service (steps 944, 946 of Fig. 9A and steps 930, 932 and 934 of Fig. 9B).

If the PBX transfers the call automatically to one of the PBX extensions that is connected to the public voice mail interface, then again there are two possibilities: either the PBX also sends the number of the transferring extension (the one that did not answer the call) (step 954) or it does not (step 956). In the former case the public voice mail interface connects the call to the public voice mail system and into the desired voice mailbox (step 948) and the process continues in a manner similar to the above-described process of leaving a voice message. In the former case the public voice mail interface connects the call to the public voice mail system and into the auto-attendant service (step 956 which is identical to step 922) as described above in connection with automatic routing to the auto-attendant service.

Reference is now made to Fig. 10 which is a simplified flow chart of a general auto-attendant procedure which takes place between the PBX and the public voice mail interface for automatic call transfer to the auto-attendant service. Fig. 10 describes in greater detail the steps 920, 922, 924, 926, 928 and 934 of Figs 9A and 9B as they are carried out by the public voice mail interface.

The procedure involved in calling the public voice mail system (step 1040) varies according to the type of public voice mail interface (as described in Figs 1A, 2A, 3A, 4A) which is employed. In an environment of the type shown in Fig. 1A, the connection is made instantaneously by sending a ring signal to the public voice mail system. In an

environment of the type shown in Fig. 2A, the connection is made by dialing the public voice mail system telephone number.

In an environment of the type shown in Fig. 3A, the connection is made by employing the conference feature of the central office. A conference is created between the caller, the public voice mail system and the public voice mail interface (as the "hub"). The conference is typically created in the following sequence (all on the central office side): dial "hook flash", wait for dial tone, dial the public voice mail system number, wait for public voice mail system to answer the call, perform steps 1050 and 1060 (answer the PBX, receive the command, translate the command and send it to the public voice mail system) and then dial hook flash again (step 1070). In this case the PBX side is not connected to the central office side but remains off-hook to disable further calls to the voice mail service on this extension.

In step 1040 the public voice mail interface calls the public voice mail system before the interface answers the PBX call. This order is preferred to make sure that there is a connection to the public voice mail system before the call is completed.

In some cases the PBX call cannot be delayed. For example, the delay between the connection to the public voice mail interface and dialing of the auto-attendant service code is fixed and short. In such cases the public voice mail interface can be set to answer the PBX immediately and receive a service command and then, or in parallel, call the public voice mail system. To enable faster identification of call completion, the public voice mail system may send a special signal as it answers the call. For example this may be a DTMF signal or another short tone.

The public voice mail interface sends to the public voice mail system the auto-attendant service command (step 1050). This is typically the identification code of the main menu of the auto-attendant service for a particular PBX. The code can also comprise two parts: a code identifying the particular PBX and a code identifying the main menu (that can be common for all PBXs). In most cases the auto-attendant service is the default service, in such cases, the auto-attendant command of the PBX is null.

Receiving a PBX command can be either via in-band DTMF dialing or over the serial link between the PBX and the public voice mail interface. Sending the command to the public voice mail system can also be carried out, independently of the manner in which it was received, via in-band DTMF dialing or over the serial link between the public voice mail interface and the public voice mail system. The same is true for commands received from the public voice mail system and commands sent to the PBX.

In steps 1070 and 1075 the public voice mail system sends a call transfer command. The command generally comprises a call transfer code and an extension number. The command is intercepted by the public voice mail interface, translated to a PBX command and is sent to the PBX.

A common in-band call transfer command to the PBX comprises: "hook flash", wait for dial tone, dial the target extension number, detect ringing tone, disconnect. In some cases the public voice mail system remains on-line to verify that someone has picked up the telephone on the called extension before it disconnects. In this case the public voice mail interface does not disconnect immediately. If the call is answered, the public voice mail system disconnects and the process is terminated (steps 1080, 1985 and 1090) otherwise the public voice mail system can send additional commands (steps 1070 and 1075 of Fig. 10 and Steps 940 and 950 of Fig. 9B).

For faster identification of the call termination by the public voice mail system (step 1080), the public voice mail system may send a special "disconnect signal" to the public voice mail interface.

It is appreciated that the system described hereinabove may also provide audiotex service. Audiotex service provides audible information to the caller. The service may provide the caller with hierarchical menus to select the required information. A simplified implementation of an audiotex service may be similar to the Auto-Attendant service as described in Fig. 10 except that steps 1070 and 1075 are irrelevant and are therefore not employed.

It is appreciated that all the commands transmitted between the PBX and the public voice mail interface and between the public voice mail interface and the public voice mail system can be communicated as in-band signals such as DTMF signals, or as digital signals over the control lines (such as 112 and 123 in Fig. 1A; 214 and 223 in Fig. 2A; 318 and 344 in Fig. 3A; etc.) The translation of the commands between PBX format and public voice mail system format can be within the same medium (e.g. DTMF format to another DTMF format) or between different media (e.g. digital to DTMF).

For example, the public voice mail interface can receive information from the PBX and/or the subscriber and/or the caller, partly over the control line connecting the public voice mail interface to the PBX and partly as DTMF signals and communicate the information to the public voice mail system in any combination of signals according to the format supported by the public voice mail system.

In the configuration described hereinabove with reference to Fig. 3A, if there is no control line 318 between the public voice mail interface and the PBX, the control signals are typically received and sent over one of the extensions 310.

It is further appreciated that in the configuration described in Fig, 3A, an incoming call on one of the lines 308 is connected to a corresponding line 304 and is switched to one of the extensions 310 at random. The public voice mail interface has to determine which line 308 corresponds to which extension 310. This may be done by transmitting a signal such as a DTMF signal or a very high or a very low tone into the extension 310 and detecting the signal over the corresponding line 318 or 308. Thereafter, commands received from the public voice mail system on line 308 are translated and sent over the corresponding extension 310 and vice versa, unless a control line is in use.

Reference is now made to Fig. 11 which is a simplified flow chart of a general voice mail procedure, which takes place between the PBX and the public voice mail interface. Fig. 11 describes steps 944, 946, or 954 and 948, 930, 932 and 934 of Figs 9A and 9B as they are carried out by the public voice mail interface.

In step 1105 an outside caller dials, through the central office, into the PBX and is transferred automatically or manually to the voice mail service. The public voice mail interface detects the ringing signal from the PBX extension and calls the Voice Mail System (step 1110). When the Voice Mail System answers the public voice mail interface call, the public voice mail interface answers the PBX call.

The PBX or the subscriber who transferred the call now sends the code, which may be null, that identifies the Voice Mail Service which is requested and the identification number of the destination voice mailbox (step 1115). The public voice mail interface translates the service code to the code of the public voice mail system that is associated with the Voice Mail Service of the particular PBX (this identifies the calling PBX) and sends the service code, the PBX identification and the identification number of the destination voice mailbox to the public voice mail system (step 1120). When the public voice mail system acknowledges the reception of this data, e.g. by starting the voice mail service, the public voice mail interface connects the PBX side with the Public Voice Mail side (step 1125).

If the PBX disconnects (step 1130), the public voice mail interface informs the public voice mail system that the call has terminated (step 1135) and waits for a possible message-waiting-indication activation (MWI) command (step 1140). If such a command is received, the public voice mail interface translates the command and sends it to the PBX (step

1145). If the public voice mail system disconnects (step 1150), the public voice mail interface disconnects the PBX side (step 1155) and the process ends.

It is appreciated that all the commands between the PBX and the public voice mail interface and between the public voice mail interface and the public voice mail system can be communicated as in-band signals such as DTMF signals, or as digital signals over the control lines (such as 112 and 123 in Fig. 1A; 214 and 223 in Fig. 2A; 318 and 344 in Fig. 3A; etc.) The translation of the commands between PBX format and public voice mail system format can be within the same medium (e.g. DTMF format to another DTMF format) or between different media (e.g. digital to DTMF).

For example, the public voice mail interface can receive information from the PBX and/or the subscriber and/or the caller, partly over the control line connecting the public voice mail interface to the PBX and partly as DTMF signals, and can communicate the information to the public voice mail system in any combination of signals according to the format supported by the public voice mail system.

In the configuration described in Fig. 3A, if there is no control line 318 between the public voice mail interface and the PBX, the control signals are typically received and sent over one of the extensions 310.

It is further appreciated that in the configuration described in Fig, 3A, an incoming call on one of the lines 308 is connected to the corresponding line 304 and is switched to one of the extensions 310 at random. The public voice mail interface has to determine which line 308 corresponds to which extension 310. This may be done by transmitting a signal such as a DTMF signal or a very high or a very low tone into the extension 310 and detecting the signal over the corresponding line 318 or 308. Thereafter, commands received from the public voice mail system on line 308 will be translated and sent over the corresponding extension 310 and vice versa, unless a control line is in use.

Reference is now made to Fig. 12 which is a simplified flow chart of a process of activating and/or deactivating a message-waiting-indication (MWI) such as in steps 908 and 932 of Figs. 9A and 9B respectively. This procedure is employed when a message waiting indication is activated or deactivated off-line rather then as a part of the same telephone session such as in steps 1140 and 1145 of Fig. 11.

It is appreciated that a message-waiting-indication command can be received and/or transmitted via telephone lines such as by DTMF signals and/or via control lines. It is

therefore also appreciated that the term "call", as used hereinbelow, may describe dialing as well as the transmission of a signal over a dedicated (leased) line.

In step 1205 the public voice mail system calls the public voice mail interface. The public voice mail interface detects the ringing signal from the public voice mail system (or central office) side and answers the call (step 1210). The public voice mail system sends the MWI activation or deactivation code and the number of the PBX extension for which the MWI has to be activated or deactivated (step 1215). The public voice mail interface receives the MWI code and data and translates it to the format supported by the PBX (step 1220). The public voice mail interface then calls the PBX and sends the translated code and data to the PBX (step 1225). The public voice mail interface acknowledges that MWI was performed and disconnects both sides (step 1230).

In the configuration described in Fig. 3A, if there is no control line 318 between the public voice mail interface and the PBX, the control signals are typically received and sent over any one of the extensions 310.

Reference is now made to Fig. 13 which is a flow chart illustrating the principal subroutine employed by the public voice mail interface configurations of Figs. 1A and 2A and their respective detailed block diagram illustrations of Figs. 6 and 7.

The principal subroutine scans the inputs of the public voice mail interface, namely the two PBX ports of lines A and B (629 of Fig. 6 and 729 of Fig. 7), the two central office ports of lines A and B (630 of Fig. 6 and 730 of Fig. 7) and the two serial data communication ports (672 and 682 of Fig. 6 and 772 and 782 of Fig. 7).

In Fig. 13 the principal subroutine starts the scan in step 1302 with the PBX side of line A (connector 610 of Fig. 6 and connector 710 of Fig. 7). If the ring detector (634 of Fig. 6 and 734 of Fig. 7) detects a ring signal, the subroutine proceeds to step 1304. If the public voice mail system side of the same line is not already engaged in a call, the subroutine proceeds to step 1306, described in greater detail in Fig. 14. If a ringing signal is not detected or if the public voice mail system side is already engaged in a call, the subroutine proceeds to step 1308.

In step 1308 the principal subroutine checks if the public voice mail system side of line A (connector 616 of Fig. 6 and connector 716 of Fig. 7) is calling. In the public voice mail interface described in Fig. 6, this check is executed by determining whether the line interface (632 of Fig. 6) detects off-hook status of the public voice mail side.

In the public voice mail interface described in Fig. 7, the check is executed by determining whether the ring detector (736 of Fig. 7) detects a ring signal. If the check determines that the public voice mail system is calling, the subroutine proceeds to step 1310.

If the PBX side of the same line is not already engaged in a call, the subroutine proceeds to step 1312, described in more detail in Fig. 16. If the central office is not calling or if the PBX side is already engaged in a call, the subroutine proceeds to step 1314.

Steps 1314 through 1324 repeat steps 1302 through 1312 for line B. It is appreciated that the public voice mail interface may comprise only one line or more than two lines.

In step 1326, the principal subroutine checks whether a byte is received from the PBX over the serial data link (112 of Fig. 1A via USART 668 of Fig. 6, 214 of Fig. 2A via USART 768 of Fig. 7). If a byte is received, the subroutine proceeds to step 1328 and checks whether a message has been completely received. If a message has been completely received, the subroutine processes the message (step 1330, described in further detail in Fig. 17 below). If no byte is received or if a message has not been completely received, the principal subroutine proceeds to step 1332.

In step 1332, the principal subroutine checks whether a byte is received from the public voice mail system over the control link, which is also termed the serial data link (123 of Fig. 1A via USART 674 of Fig. 6 and 223 of Fig. 2A via USART 774 of Fig. 7). If a byte is received the subroutine proceeds to step 1334 and checks if a message has been completely received. If a message has been completely received, the subroutine processes the message (step 1336, described in further detail in Fig. 18 below). If no byte is received or if a message is not completed the principal subroutine proceeds to step 1338.

It is appreciated that either of the serial data links may not be in use as a matter of local configuration of the public voice mail interface.

In step 1338, the principal subroutine processes any of the subroutines described below in Figs. 14, 16, 17 and 18 that have not yet been completely processed and are thus considered pending.

Reference is now made to Fig. 14, which is a more detailed flow chart, illustrating in greater detail steps 1306 and 1318 of Fig. 13 that are identical to each other.

In step 1402 the subroutine flags the PBX side of the appropriate line as "engaged" to disable the subroutine from answering the public voice mail system if it calls on the same line. The subroutine then flags itself as "pending" so that it can surrender use of the

processor when the subroutine is waiting for an external event (such as the reception of a DTMF signal) and can regain use of the processor when the event occurs. The subroutine then instruct the ring generator 640 (Fig. 6) to send a ringing signal or the line interface 732 (Fig. 7) to go off-hook and signal the public voice mail system or the central office that the public voice mail interface wishes to start a session.

The next two steps 1404 and 1406 are not applicable for the public voice mail interface configuration of Fig. 1A. In these steps the subroutine detects the dial tone of the central office 210 (Fig, 2A) and dials to the public voice mail system 202 (Fig. 2A).

In step 1408 and 1410 the subroutine detects that the public voice mail system has answered the call and therefore instructs the line interface 631 of Fig. 6 or 731 of Fig. 7 to answer (go "off-hook") the PBX call.

As stated before, the sequence described above where the public voice mail system is called before the PBX call is answered may be reversed in the cases where answering the PBX can not be delayed without loss of information.

In steps 1412 through 1418, the subroutine receives a command from the PBX, translates it into the same command but in the format supported by the public voice mail system and sends it to the public voice mail system. In some cases where a control link to the PBX (112 on Fig. 1A, 214 of Fig. 2A) is operative, some or all of the data to be incorporated in the command bound for the public voice mail system may be received via the control link from the PBX. Also, in some cases where a control link to the public voice mail system (123 of Fig. 1A, 223 of Fig. 2A) is operative, some or all of the data to be incorporated in the command bound for the public voice mail system may be transmitted via the control link from the public voice mail system.

In steps 1420 and 1422 the subroutine receives an acknowledgment from the public voice mail system and instructs the relay (626 of Fig. 6, 726 of Fig. 7) to connect the two sides of the line.

In steps 1424 through 1436 the subroutine repeatedly scans both sides to detect whether either the PBX or the public voice mail system has disconnected. If either side has disconnected, the subroutine disconnects the other side and turns off the "PBX side engaged" and "process pending" flags. As a part of this repeated scan the subroutine observe both sides of the line as well as both control lines, if available, for more commands (step 1436). If a command is detected, the subroutine translates the command and sends it to the other side of the line.

Reference is now made to Fig. 15A which is a more detailed flow chart illustration of a simplified subroutine implementing step 1436 of Fig. 14. The subroutine described in Fig. 15A communicates commands between the PBX and the public voice mail interface. The subroutine is processed repeatedly, as a part of the subroutine of Fig. 14, as a part of the principal subroutine of Fig. 13.

When a DTMF digit is detected (step 1502), it is added to a command buffer until a complete command is received (step 1506). The command is then analyzed (step 1508), translated and sent to its destination (steps 1510, and either step 1512 or step 1514).

Reference is now made to Fig. 15B which is a more detailed flow chart illustration of a simplified subroutine implementing step 1434 of Fig. 14. The subroutine sends a disconnect command to the public voice mail system (step 1552) and waits for a response command such as a message waiting indication command or a disconnect acknowledge command. When a DTMF digit is detected (step 1554) it is added to a command buffer until a complete command is received (step 1558). If the command received is not a disconnect acknowledge (step 1560), the command is translated from a public voice mail system command to a PBX command, and sent to the PBX (step 1562). If the received command is a disconnect acknowledge, the PBX side is disconnected (on-hook), the subroutine terminates (step 1566) and the subroutine of Fig. 14 continues to step 1428.

Reference is now made to Fig. 16 which is a more detailed flow chart illustrating steps 1312 and 1324 in the subroutine of Fig. 13 that are identical to each other.

In step 1602 the subroutine flags the public voice mail system side of the appropriate line as "engaged" to disable the subroutine from answering the public voice mail system, if it calls on the same line. The subroutine then flags itself as "pending" so that it can surrender use of the processor when the processor is waiting for an external event (such as the reception of a DTMF signal) and regain use of the processor when the event occurs. Then the subroutine instructs the line interface (632 of Fig. 6, 732 of Fig. 7) to connect (off-hook) to the public voice mail system side.

In step 1604, the subroutine determines whether the public voice mail system sends the command in DTMF format or by a modem. If a modem is employed, the subroutine instructs (step 1606) the appropriate relay (684 of Fig. 6, 784 of Fig. 7) to connect the telephone line to the USART (674 of Fig. 6, 774 of Fig. 7) and the program continues with the appropriate subroutine described below as a part of the subroutine described in Fig. 18.

If the information from the public voice mail system is sent by DTMF signals, the subroutine receives the DTMF digits from the public voice mail system (step 1608), identifies the command (step 1610) and translates the public voice mail system command to the PBX command (step 1612).

In step 1614, the subroutine instructs the line interface (631 of Fig. 6, 731 of Fig. 7) to connect (off-hook) to the PBX side. When the PBX answers the call initiated by the subroutine, it sends the translated voice mail system command to the PBX (step 1616) and optionally receives an acknowledgment (step 1618).

If a connection between the two sides of the line is required, such as to enable a voice conversation between a subscriber of the PBX and the public voice mail system, (step 1620) the subroutine instructs the relay (626 of Fig. 6, 726 of Fig. 7) to connect the PBX side with the public voice mail system side.

In steps 1624 through 1636, the subroutine repeatedly scans both sides to detect whether either the PBX or the public voice mail system has disconnected. If either side has disconnected, the subroutine disconnects the other side and turns off the "public voice mail system side engaged" and "process pending" flags. As a part of this repeated scan, the subroutine monitors both sides of the line as well as both control lines, if available, to detect additional commands (step 1636). If a command is detected, the subroutine translates the command and sends it to the other side of the line. Steps 1636 and 1634 are described in further detail in Figs. 15A and 15B respectively.

It is appreciated that the commands received by the above-described subroutines appearing in Figs, 14, 15A, 15B and 16 can be sent to a corresponding destination via the telephone lines as described above or via the control lines as described below.

Reference is now made to Fig. 17 which is a more detailed flow chart illustrating the subroutine of a preferred implementation of step 1330 of the principal subroutine of Fig. 13. This subroutine is executed after an interrupt service routine, that receives one byte at a time from the control line (112 of Fig. 1A, 214 of Fig. 2A via the corresponding USART 668 of Fig. 6, 768 of Fig. 7), signals that a complete message has been received.

In step 1702 the subroutine flags itself as "pending" so that it can surrender use of the processor when it is waiting for an external event and regain use of the processor when the event occurs. After flagging itself, it then analyzes the PBX command (step 1704). The PBX command can be sent to the public voice mail system via the control line (USART 674 of

Fig. 6, USART 774 of Fig. 7), or, if the control line is not in use, via the telephone line (108 of Fig. 1A, 208 of Fig. 2A).

When the communication medium is selected (step 1706), the PBX command is translated to a format supported by the public voice mail (step 1708 or 1710) over the selected communication medium. The control line to the public voice mail system can be either a dedicated line (123 of Fig. 1A, 223 of Fig. 2A) or one of the telephone lines (108 of Fig. 1A, 208 of Fig. 2A). The subroutine determines which type of connection is in use (step 1712).

If a telephone is to be used, the subroutine selects one of the telephone lines that is not in use and instructs the appropriate relay (684 of Fig. 6, 784 of Fig. 7) to connect the USART to the line (step 1714). If a dedicated line is chosen, the subroutine advances directly to step 1716. The subroutine now sends the command (steps 1716, 1718 and 1720) and when this process ends the subroutine turns off the "pending" flag (step 1722) and terminates.

Reference is now made to Fig. 18 which is a more detailed flow chart illustrating the subroutine of a preferred implementation of step 1336 of the principal subroutine of Fig. 13. This subroutine is executed after an interrupt service routine, that receives one byte at a time from the control line (123 of Fig. 1A, 223 of Fig. 2A via the corresponding USART 676 of Fig. 6, 776 of Fig. 7), signals that a complete message has been received.

In step 1802 the subroutine flags itself as "pending" so that it can surrender use of the processor when it is waiting for an external event and regain use of the processor when the event occurs. Following the flagging, the subroutine analyzes the public voice mail system command (step 1804).

The command can be sent to the PBX either via the control line (USART 668 of Fig. 6, USART 768 of Fig. 7), or, if the control line is not in use, via the telephone line (112 of Fig. 1A, 214 of Fig. 2A). When the communication medium is selected (step 1806), the PBX command is translated to a format supported by the public voice mail (step 1808 or 1810) over the selected communication medium.

If a telephone is to be used, the subroutine selects one of the telephone lines that is not in use (step 1812 and 1814). The subroutine now sends the command by dialing and sending a DTMF message (step 1816) or by using the control line (step 1818) as well as using steps 1820 and 1822. When the entire message is sent the subroutine turns off the "pending" flag (step 1824) and terminates.

Reference is now made to Figs. 19, 20 and 21 that together constitute flow chart illustrations of the principal subroutine for the configuration of the public voice mail interface as described in Fig. 3A and Fig. 8. The principal subroutine described in Fig. 19 is similar to the principal subroutine described hereinabove with reference to Fig. 13. The subroutines described in Figs. 20 and 21 are more detailed representations of the steps 1904 and 1908 of Fig. 19 and are similar to the subroutines described in Figs. 14 and 16. Steps 1930, 1940 and 1942 are described in more detail in Figs. 17, 15A and 18.

Reference is now made to Fig. 20 which is a more detailed flow chart illustrating of step 1904 of Fig. 19. In the public voice mail interface configuration described in Fig. 3A and Fig. 8 there is no fixed correlation between the PBX side and the central office/public voice mail system side. Typically a telephone call is received from the central office (line 308 of Fig. 3A), through the public voice mail interface, to the PBX (line 304 of Fig. 3A) and is transferred, automatically by the PBX or manually by one of the PBX subscribers (via subscriber telephone 316 of Fig. 3A), via one of the PBX extensions 310 (Fig. 3A), to the public voice mail interface. The subroutine described in Fig. 20 determines which of the central office lines corresponds to the call transferred to the specific PBX extension that now calls the public voice mail interface.

In step 2002 the subroutine flags itself as "pending" so that it can surrender use of the processor when it is waiting for an external event and regain use of the processor when the event occurs. The subroutine then connects to the PBX side (step 2004), receives DTMF digits from the PBX (step 2006) and identifies the command (step 2008).

The subroutine then sends a line identification signal such as a DTMF signal or a very low or a very high frequency signal through the PBX extension until the signal is detected over one of the central office lines (step 2010). This indicates the current correlation between the specific PBX extension and the specific central office line.

The subroutine now translates the command received from the PBX to the command format supported by the public voice mail system and sends it to the public voice mail system (step 2012) either as a DTMF command via the telephone line, through the control line 344 (Fig. 3A) or as a control command in a dial-up process via one of the telephone lines as described above in Fig. 17.

The subroutine continues to observe the line for further commands (step 2014). When a complete command is received (step 2016) the command is identified and analyzed (step 2018) and sent to the appropriate destination (steps 2020, and either step 2012 or step

2022). If one of the lines is disconnected (step 2024) the subroutine concludes the call (steps 2026 and 2028), as described in more detail in Fig. 15B.

Reference is now made to Fig. 21 which is a more detailed flow chart illustrating step 1908 of Fig. 19. In step 2002 the subroutine receives a call from the central office side and identifies it as a call coming from the public voice mail system. This may be done by means of Automatic Number Identification mechanism, also known as "caller ID", or by means of a parallel command arriving over the control line from the public voice mail system, or as a DTMF string transmitted by the public voice mail system when the call is answered.

When a public voice mail system call is identified (step 2102) the subroutine flags itself as "pending" (step 2104) so that it can surrender use of the processor when it is waiting for an external event and regain use of the processor when the event occurs. The subroutine then disconnects (step 2106) the PBX line (304 of Fig. 3A), selects (step 2108) and calls (step 2110) a free PBX extension (310 of Fig. 3A).

The subroutine then receives DTMF digits from the public voice mail system (step 2112) until it identifies a command (steps 2114, 2116). The subroutine now translates the command received from the public voice mail system to a command format supported by the PBX and sends it to the PBX (steps 2118 and 2120) either as a DTMF command via the extension (310 of Fig. 3A) or through the control line (344 of Fig. 3A).

The subroutine continues to observe the line for further commands from either side. When a complete command is received, it is identified, analyzed, translated and sent to the appropriate destination (steps 2112 through 2122). If one of the lines is disconnected (step 2124) the subroutine concludes the call (steps 2126 and 2128) as described in more detail in Fig. 15B.

The public voice mail interface of the configuration described in Fig. 4 is incorporated within the PBX. Therefore the principal subroutine of the PBX performs the task of the principal subroutine described in Fig. 13. There is no need to detect a calling event on the central office side since this is a regular feature of the PBX and there is no need to detect calling events on the PBX side since it is internal to the PBX. Additionally, there is no need for a physical control link to the PBX. The subroutines described in Figs 14A, 14B, 15, 16, 17 and 18 are therefore reduced to their translation features and are operated directly by the principal subroutine of the PBX.

It is appreciated that the public voice mail interface may comprise only one telephone line or alternatively more than the two telephone lines A and B.

Reference is now made to Fig. 22A which is a simplified block diagram illustration of a public voice mail system (PVMS) coupled to a central office (CO), a private branch exchange (PBX), a public voice mail interface (PVMI) and a local area network server and workstations to provide a unified messaging service in accordance with yet another preferred embodiment of the present invention.

As used hereinbelow and throughout, the term "unified messaging" denotes a messaging system or a service that provides the following features:

The system or the service can receive, store and send messages of various different media such as voice, fax, text, electronic mail, image, video, etc.

A user can access his mailbox via various terminals such as a telephone, a facsimile machine or a computer terminal. The user can create, retrieve, forward, etc. messages of the different media supported by the system or the service. For example, the user can view his voice and fax messages via his computer terminal and optionally even retrieve them. The user can retrieve his electronic mail messages via fax machine or even hear them through a telephone.

There are two basic methods to provide unified messaging: either by a single system that supports all the media or by integrating two or more systems such as a voice mail system and an electronic mail system. In both cases it is required to provide a link between the computer system and the voice mail system (or the unified messaging system) so that a subscriber is able to use his computer terminal or personal computer to access the messaging system or to use a telephone to access the electronic mail server.

Fig. 22A illustrates a simplified block diagram of a unified messaging system in accordance with one preferred embodiment of the present invention and is based on the configuration, described and illustrated in Fig. 2A, and a LAN-based computing environment. The system of Fig. 22A comprises a public voice mail system (PVMS) 202 coupled to a central office (CO) 210, a private branch exchange (PBX) 200, a public voice mail interface (PVMI) 206, a LAN server 230 and a plurality of workstations 228, interconnected via a LAN 226. In Fig. 22A a connection 224, between the public voice mail interface and the LAN server 230, is provided by means of a LAN interface included within the public voice mail interface 206.

Reference is now made to Fig. 22B which illustrates a simplified block diagram of another embodiment of a unified messaging system, constructed and operative in accordance

with the configuration illustrated and described in Fig. 2A. The structure of Fig. 22A is similar to that of Fig. 22B except that the connection between the public voice mail interface 206 and the LAN server 230 is provided via a serial communication link 232.

It is appreciated that the embodiments described in Figs. 1A, 3A and 4A may be similarly modified to provide a unified voice mail messaging service as illustrated and described in Fig. 22A.

Reference is now made to Fig. 23 which illustrates a simplified block diagram of a public voice mail interface configured to provide unified messaging, in the configuration of Fig. 22A, by means of a LAN interface 224 (Fig. 22A). Thus, Fig. 23 is essentially similar to the interface described with respect to Fig. 7 with the addition of a LAN interface 784 and a connector 786. The connector 786 connects the LAN 784 to LAN 22 (Fig. 22A).

Reference is now made to Fig. 24 which illustrates a simplified block diagram of a public voice mail interface configured to provide unified messaging in the configuration of Fig. 22B by means of the serial communication link 232 (Fig. 22B). The serial communication link 232 is connected to the LAN server 230. (Fig. 22B).

It is appreciated that the configurations described in Figs. 1A, 2A, 3A and 4A, as well as the implementations described in Figs. 6, 7 and 8, may employ various telephone standards, such as loop start, ground start, E&M and ISDN.

It is also appreciated that it is possible to use a digital signal processor (DSP) instead of the microprocessor, the DTMF receivers, the DTMF transmitters, USARTs and the modem.

It is further appreciated that the public voice mail interface may comprise means to use only one copper pair to communicate two or more telephone sessions between the public voice mail interface and the public voice mail system of Fig. 1A or between the public voice mail interface and central office of Fig. 2A. These communication means may be implemented by using an ISDN line, or another means of digital telephone access network, with or without voice compression.

It is further appreciated that the present invention may also be implemented with other communication and telephone infrastructures such as telephone services over cable television networks or by means of wireless local loop.

Reference is now made to Figs. 25A and 25B which illustrate an alternative embodiment of the present invention wherein the PBX and the Public Voice Mail Interface are connected to separate central offices. Such a configuration is particularly relevant to cellular

telephone and radio services, wherein a cellular central office and a land line central office may be operated by different service providers.

Referring now to Fig. 25A, there is provided a simplified block diagram illustration of a cellular public voice mail system coupled to a cellular central office and a PBX in accordance with another preferred embodiment of the present invention, which represents a modification of the embodiment of Fig. 2A. In the embodiment of Fig. 25A, a PBX 2200 is connected to a central office 2201 and receives voice mail service from a cellular public voice mail system 2202 via a cellular central office switch 2204, as distinguished from the public voice mail system 202 of Fig. 2A, which is connected to central office 210 of Fig. 2A. The cellular public voice mail system 2202 may be identical with public voice mail system 202 of Fig. 2A and the cellular central office 2204 may comprise equipment which is identical to that in central central office 210 of Fig. 2A.

A plurality of PBX telephone extensions 2206 are connected to a public voice mail interface 2208. Public voice mail interface 2208 may be identical to public voice mail interface 206 (Fig. 2A) with the addition of two cellular transcievers, such as Phonecell SX from Tellular Corporation, 647 North Lakeview Parkway, Vernon Hills, IL 60061, USA. Public voice mail interface 2208 communicates with a cellular radio base station 2210 that connects to the cellular central office 2204 and through lines 2212 to the cellular voice mail system 2202.

A control link 2214 may optionally be provided between the PBX 2200 and the public voice mail interface 2208. Optionally, the voice mail system 2202 and the cellular central office 2204 may also be connected by means of an additional data link 2216, which carries data and control signals between the central office 2204 and the voice mail system 2202.

The signals communicated between the PBX 2200 and the public voice mail interface 2208 over line 2214 may be communicated between public voice mail interface 2208 and voice mail system 2202 as DTMF signals or as modem signals.

The public voice mail system of Fig. 25A preferably contains mailboxes allocated to telephone extensions and individuals associated with the PBX. It is possible to access these mailboxes by means of subscriber telephones 2218 connected to the PBX or by means of any other telephone connected to the telephone network.

It is appreciated that in the same manner that Fig. 25A is a modification of the embodiment of Fig. 2A, similar modifications may be made to the embodiments of Figs. 3A

and 4A so that the PBX and the Public Voice Mail Interface are connected to separate central offices.

Reference is now made to Fig. 25B, which is a simplified block diagram illustration of a plurality of landline and cellular public voice mail systems coupled to landline and cellular central offices and PBXs in a landline and cellular telephone networks in accordance with the embodiment of Fig. 25A. Elements in Fig. 25B which may be identical to those appearing in Fig. 25A are indicated by identical reference numerals

In Fig 25B, the two public voice mail interfaces 2208 communicate with the cellular radio base stations 2210 that are closest to them, enabling the respective PBXs 2200 to be served by cellular voice mail system 2202 via cellular central office 2204.

It is appreciated that in the same manner that Fig. 25B is a modification of the embodiment of Fig. 2B, similar modifications may be made to the embodiments of Figs. 3B and 4B so that the PBX and the Public Voice Mail Interface are connected to separate central offices.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the features described hereinabove as well as variations and modifications thereof which would occur to a person skilled in the art upon reading the foregoing description and which are not in the prior art.